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# (54) Hot runner nozzle

(57) A hot runner nozzle structure provides insulation to reduce heat transfer to a utilizing tool and to increase accuracy of temperature measurement and control. A shaft foot (48) of extremely low heat conductivity is used to separate a point of contact between a feed tube shaft (17) and the tool (27). The shaft foot (48) may be formed of titanium for example. An insulating cap (53) of extremely low heat conductivity surrounds the shaft foot (48) in the vicinity of the nozzle tip (26). The cap (53) may be formed of PEEK or of titanium for example. Gaps may be provided between the insulating cap (53) and shaft foot (48) and/or between the shaft foot (48) and feed tube shaft (17). In an alternate embodiment having smaller dimensions, an insulating ring (54) is provided at the end of the feed tube shaft. The structure, combined with a positioning sleeve surrounding the feed tube shaft, permits placing a heat sensor (34) extremely close to the nozzle tip (26) in order to obtain more accurate temperature control.

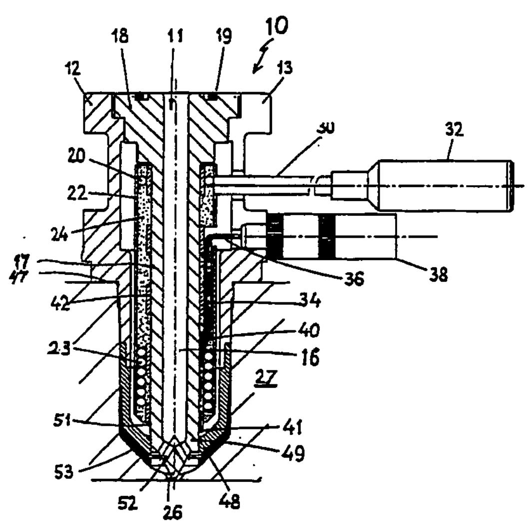


Fig. 1

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## Description

### Field of the Invention

[0001] This invention relates broadly to injection molding devices, and more particularly to an improvement in a nozzle used in such devices.

[0002] As known in the art, a mold (such as a cavity mold) is typically used when an article is formed by injection molding. In such an injection process, runners are provided to carry plastic or other material from one cavity (for one part of the article) to another cavity (for another part, or article). The injection material tends to solidify in these runners and must be removed, thus leading both to excessive waste of material and to increased costs for removal of the waste material. It is thus known to heat the material in the runner and in the injection nozzle. Associated with such heating is a need for accuracy in determination of the temperature in order to provide better control of the injection process.

[0003] However, accurate measurement of the temperature at the feed tube end could not be accurately obtained in prior art temperature measurement devices for a hot runner nozzle. Indeed, even in the parent application previously filed by the present applicant, such measurement provided an improvement in measurement accuracy but did not detect the temperature at the feed tube end.

[0004] It is accordingly an object of the present invention to provide accurate measurement of the temperature of the plastic mass flowing through the injection nozzle.

[0005] It is another object of the invention to provide accurate measurement of the heating unit temperature at the end of a feed tube of a hot runner nozzle and to enable control of the heating temperature with greater precision.

[0006] It is a further object of the invention to reduce heat dissipation from the bottom end of a hot runner nozzle, and from the tip thereof, to the tool.

[0007] It is a more specific object of the invention to provide a cap formed of a metal having extremely low heat conductivity at a bottom end of the nozzle. In order further to reduce heat dissipation, it is also an object of the invention to provide an insulating cap surrounding a shaft foot made of extremely low heat conductivity material, wherein the latter may be threadedly engaged with the nozzle housing.

[0008] It is yet another object of the invention to reduce heat dissipation still further by providing at least one insulating gap between one or more of the components at the end of the feed tube, such as the feed tube shaft, the shaft foot, and the insulating cap of the nozzle.

[0009] It is still a further object of the invention to provide a heating unit for a feed tube shaft in a hot runner nozzle which extends to a region in the vicinity of the tip, in which the tube shaft has no surface contact with the tool, to provide a heat sensor having a measuring point between the end of the heating coil and the tip, in which the measuring point and at least a portion of the heating coil are surrounded by a material having extremely low heat conductivity, such as titanium, while further providing an insulating cap on the titanium or similar material.

[0010] It is still another object of the invention to provide such advantages to nozzles which may be used both in larger and smaller environments, and specifically to nozzles structured for mounting in tools having reduced volume.

[0011] For such structures of reduced volume it is thus an object of the of the invention to provide a hot runner nozzle in which a receiving ring structure surrounds a portion of the hot runner nozzle tip, the ring being formed of material having extremely low heat conductivity, such as titanium, thus to reduce the volume of the hot runner nozzle in the vicinity of the heating coil and heat sensor measuring point.

[0012] It is yet another object of the invention to provide a hot runner nozzle structure including a heater and temperature sensor which simplifies manufacture of the same.

[0013] Still another object of the invention is to provide a perforated tube for supporting and stabilizing a heating coil during a casting process for a brass seal, to permit the cast brass to flow therethrough and thus to envelope the heating coil properly.

[0014] It is thus still another object of the invention to provide a novel method for manufacturing hot runner nozzles to accurate small sizes for use in injection mold tools and manifolds of varying designs and having varying sizes.

[0015] These and other objects, features and advantages of the present invention will become readily apparent to those skilled in the art from the following description and drawings, wherein there is shown and described a preferred embodiment of the invention, simply by way of illustration and not of limitation of one of the best modes (and alternative embodiments) suited to carry out the invention. The invention itself is set forth in the claims appended hereto. As will be realized upon examination of the specification and drawings and from practice of the same, the present invention is capable of still other, different, embodiments and its several details are capable of modifications in various obvious aspects, all without departing from the scope of the invention as recited in the claims. Accordingly, the drawings and the descriptions provided herein are to be regarded as illustrative in nature and not as restrictive of the invention.

### Brief Description Of The Drawings

[0016] The accompanying drawings, incorporated into and forming a part of the specification, illustrate several aspects of a preferred embodiment of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

Fig. 1 shows a preferred embodiment of a hot runner nozzle assembly in accordance with the invention;

Fig. 2 shows a detail of the structure shown in Fig. 1;

Fig. 3 shows a modification of the embodiment of Fig. 1; and

Fig. 4 shows a detailed view of a portion of the embodiment Fig. 3.

## Detailed Description

[0017] Referring now to the drawings, there is shown in Fig. 1 a nozzle 10 in accordance with the invention, the nozzle having a tip 26 and being used in a tool 27. Tool 27 does not form part of the present invention.

[0018] Nozzle 10 includes a housing 12 within which is provided a structure having an inlet 11 and a feed tube hollow 16. Feed tube hollow 16 is formed in a structure including a feed tube head 18 and a feed tube shaft 17, extending from an upper surface of housing 12 to tip 26. Housing 12 includes a recess 13 and a sealing ring 19. A heating unit 20 for the nozzle includes an outer steel sheath 22, a heating coil 23, a stabilizing tube in the form of a perforated copper sheet 42, for example, and a compound body 24 made of brass which is cast to form the structure.

[0019] The heating coil 23 may be a helical double-wound (bifilar) coil, a sheet metal resistor of generally cylindrical shape for example, or any other suitable heating device. Tube 42 advantageously provides an advantage in forming the apparatus, by supporting and stabilizing heating coil 23 during a casting process for the compound body 24. Tube 42, which is preferably a perforated tube. prevents inward movement of heating coil 23 toward the outer surface of the feed tube shaft during casting. Thus, the inner diameter of heating unit 20, at the outer diameter of feed tube shaft 17, is not damaged by movement of the heating coil. Moreover, by preventing inward movement of any portion of coil 23 beyond an acceptable limit, tube 42 assures that the coil is not damaged during boring of the feed tube hollow 16. The tube 42 is perforated in order to provide a cross-sectional area for the compound body which is greater than only the spacing between steel sheath and tube 42. Thus, during the casting process the cast brass flows through the perforations in tube 42 in order fully to envelope the heating coil 23.

[0020] Also illustrated in Fig. 1 are connectors 32 and 38 for heating coil 23 and for a heat sensor 34, respectively. A number of leads provide a connection means 30 between connector 32 and heating coil 23. Connection wiring 36 is provided between connector 38 and beat sensor 34. The specific shape arrangement and configuration of recesses in the housing 12 to accommodate the various connectors and wiring connections are subject to variations as may be required.

[0021] In order to provide for more accurate temperature detection, a groove is provided at a lower portion of the device. More specifically, the groove is provided in the outer surface of feed tube shaft 17 under heating coil 23. The compound body 24 may include a separate groove therein to enable placing the sensor within the groove in shaft 17. The groove in shaft 17 accommodates the heat sensor 34 which, at an upper portion thereof, is included within a tube 40, positioned within a groove in the compound body 24, or otherwise meandering therethrough.

[0022] In a particular configuration, the sensor tube 40 is mounted at an upper portion of the housing within the compound body 24, upon entering the housing from connector 38, between the tube 42 and sheath 22 as seen in Fig. 1. Thus, sensor 34 is received within the bore of sheath 22 at this portion. In the lower portion of the nozzle, the sensor 34 is seated within coil 23. Preferably, coil 23 has a variable pitch and, as illustrated in Fig. 1, has a small pitch at the lower portion of the nozzle. Thus, there is an improved heat transfer between the heating coil 23 and sensor 34 at the lower portion. As above noted, at this portion the sensor is seated in a groove formed in a lower portion of the outer periphery of feed tube shaft 17. Thus, heat sensor 34 is in contact with the shaft 17 to obtain an accurate measurement of the temperature of the plastic material flowing therethrough at measuring point 41, at the bottom end 49 of the shaft. Perforated tube 42 is structured appropriately to include a vertically extending longitudinal separation, or void, therein in order to accommodate the heat sensor within heating coil 23 as shown in Fig. 1.

[0023] In order to stabilize the assembly, a fixing ring 51 is provided within a peripheral groove (not shown) at the bottom end 49 of feed tube shaft 17. Ring 51 prevents vertical movement of heating coil 23 and the compound body 24 along the feed tube, and particularly toward the tip 26. Preferably, fixing ring 51 includes an eye, or other opening, therein.

[0024] As apparent in Fig. 2, the heat sensor 34 is positioned within the opening in fixing ring 51, thus defining position of the measuring point 41. While the groove in feed tube shaft 17 and the eye in fixing ring 51 may be aligned, it will be appreciated that the groove need not be entirely vertical and may include a meandering portion to accommodate positioning of heat sensor 34 at the eye of ring 51. However, by providing a groove in the outer surface of feed tube shaft 17, the present invention eliminates a requirement which might otherwise arise, such as for boring an additional hole into the shaft. Moreover, in an embodiment wherein heat sensor 34 is included within heating coil 23 and immediately adjacent to (or in contact with) the feed tube shaft 17, rather than being within a groove provided therein, assembly may be simplified still further, particularly in light of establishment of the measuring point 41 by the eye in fixing ring 51.

[0025] In order to even out temperature distribution and to minimize temperature dissipation, the embodi-

ment of Fig. 1 includes the following elements.

[0026] A shaft foot 48 is provided to prevent heat loss and dissipation from the bottom end 49 of shaft 17 to housing 12. As illustrated in Fig. 1, shaft foot 48 may be threadedly mounted to housing 12. To assure still less heat dissipation, and thus increased accuracy in measurement and control, the inventive structure is further configured to assure that the shaft foot touches tool 27 only at a position far removed from the tip 26 and thus the gate point. It will thus be appreciated that fixing ring 51 prevents movement of the heating coil toward the shaft foot 48. Preferably, shaft foot 48 is made of a material having a heat transfer characteristic less than 15 watts per meter degree Centigrade. It is preferred that a material such as titanium be utilized for the shaft foot.

[0027] As still further insulation, there is provided a gap between the shaft foot 48 and sheath 22 and the compound body 24 and heating coil 23 contained therein.

[0028] In light of the expense associated with titanium materials, the shaft foot is shown as extending along only a portion of the housing. In the embodiment of Fig. 1, the shaft extends approximately one-half the distance between a shoulder 47 formed in the housing and the tip 26. While the titanium shaft foot may be threadedly mounted on the housing, other modes of attachment may be utilized, such as bonding and the like.

[0029] As yet another feature of the invention, an insulating cap 53 is provided in order to lengthen the heat transfer path and reduce further any heat dissipation or heat and transfer to tool 27. The cap 53 is preferably formed of a low heat conductivity material, such as a plastic. The plastic used for the cap 53 is, as may be expected, of a material having a higher melting point than the material to be processed. For example, insulating cap 53 is preferably formed of a temperature-resistant material such as PEEK (polyether etherketone). The insulating cap 53 thus fills the space between the contour of the tool 27 which receives nozzle 10 and the tip 26. This structural feature thus prevents plastic flow from filling this space, where the plastic might deteriorate or spill out and enter the article being made. It should also be recognized that cap 53 also assists in quickly changing plastic masses of different colors.

[0030] The insulation thus may surround the entire titanium shaft foot. However, in light of expenses associated with PEEK, the preferred embodiment illustrated in Fig. 1 surrounds the titanium shaft foot for a vertical (longitudinal) distance of approximately the diameter of the housing. As apparent from Figs. 1 and 2, a gap may be provided between shaft foot 48 and cap 53, thus further to reduce heat dissipation. Cap 53 is placed over the titanium shaft foot as a sleeve which, as above noted, may be retained in place by the tool body.

[0031] Thus, with a high heat transfer tip 26, formed of a material such as tungsten carbide (preferably reinforced to withstand abrasion), and low heat transfer shaft foot and insulating cap, it will be appreciated that heat loss to the tool body is minimized and that the accuracy of temperature measurements and control for the injection material and the heating coil are improved significantly by the invention.

[0032] In Fig. 3 there is shown a modification of the inventive structure of Fig. 1. More particularly, in an environment wherein a reduced volume injection nozzle and/or heater is required, and where there may not be sufficient room for the titanium cap forming shaft foot 48 and the insulating cap 53, the nozzle 10 may include a centering sleeve 29. Centering sleeve 29 is preferably clipped on to the housing, rather than being soldered or screwed thereto. Bottom end 49 of the feed tube shaft 17 seals directly in tool 27.

[0033] However, in order to obtain various of the advantages arising from the inventive concept, to the extent possible in such a reduced volume configuration, there is provided a receiving ring 54 made of a material having extremely low heat conductivity. The receiving (or insulating) ring 54 is preferably made of titanium, to minimize heat loss in the region of tip 26.

[0034] As apparent from Fig. 4, the internal horizontal shoulder on ring 54 prevents upward movement thereof in response to material pressure. The ring may have gaps or grooves therein and, while not as efficient as the more complete insulation system of Figs. 1-2, nonetheless provides a compromise for situations wherein a smaller diameter structure is required. It is also noted that, because there is no contact in the embodiment of Fig. 3 between either the heating element or the feed tube and the tool 27, heat transfer is reduced even without presence of the titanium shaft foot structure.

[0035] As an illustration of the savings attained by the inventive concept with respect to heat loss and requirements for additional heating of the plastic injection material, it is estimated that for the embodiment of Figs. 3-4, nozzle operation would require a temperature which is approximately 20 degrees (C) higher without the use of insulating ring 54. The savings are still greater for the embodiment of Figs. 1-2.

[0036] The foregoing description of the preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed, since many modifications or variations thereof are possible in light of the above teaching. All such modifications and variations are within the scope of the invention. The embodiments described herein were chosen and described in order best to explain the principles of the invention and its practical application, thereby to enable others skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated therefor. It is intended that the scope of the invention be defined by the claims appended hereto, when interpreted in accordance with the full breadth to which they are legally and equitably entitled.

## List of Reference Symbols

**[0037]**

| | |
|---|---|
| F | mold cavity |
| V | prechamber bush |
| 10 | hot runner nozzle |
| 12 | housing |
| 13 | recess |
| 14 | screw hole |
| 16 | material pipe/bush |
| 17 | shaft |
| 18 | head |
| 19 | sealing ring |
| 20 | heating unit |
| 22 | steel sheath |
| 23 | heating coil |
| 24 | seal (body) |
| 25 | inner wall |
| 26 | tip |
| 28 | centering screw |
| 29 | centering sleeve |
| 30 | connection points |
| 31 | recess |
| 32 | connector |
| 34 | heat sensor |
| 36 | connection wiring |
| 38 | connector |
| 40 | sensor tube |
| 41 | extending portion |
| 42 | perforated sheet |
| 44 | recess/cutout |
| 46 | segment |
| 48 | shaft foot |
| 49 | bottom end |
| 50 | tip insert |
| 51 | fixing ring |
| 52 | outlet |
| 53 | insulating cap |
| 54 | insulating ring |

## Claims

1. A hot runner nozzle assembly (10) comprising a housing (12); an externally heatable feed tube (16) in the housing (12), the feed tube (16) including a shaft (17) within the housing (12) and a tip (26) at a bottom end thereof, wherein heating means (20) for the feed tube (16) include a heater extending towards the tip (26) and a heat sensor (34) extending beyond the heater towards the tip (26).

2. An assembly according to claim 1, wherein the heater comprises a heater coil (23) surrounding the shaft (17) and the heat sensor (34) includes an extending portion (41) between the shaft (17) and the heater coil (23).

3. An assembly according to claim 2, wherein the shaft (17) includes a positioning groove, the extending portion (41) being seated in the positioning groove within the heating coil (23).

4. An assembly according to claim 2 or 3, comprising a shaft foot (48) of a material having extremely low heat conductivity, the shaft foot (48) surrounding the heating coil (23) along a portion of the shaft (17), thereby reducing heat dissipation from the tip (26) to the housing (12).

5. An assembly according to claim 4, wherein the shaft foot (48) is made of titanium.

6. An assembly according to claim 4 or 5, comprising an insulating cap (53) surrounding a portion of the shaft foot (48) and isolating the portion of the shaft foot (48) from a tool (27) including the nozzle (10), thereby lengthening a heat transfer path from the tip (16) to the tool (27) including the nozzle (10).

7. An assembly according to claim 6, wherein the insulating cap (53) is made of a PEEK (polyether etherketone) material.

8. An assembly according to claim 6 or claim 7, wherein the insulating cap (53) surrounds the shaft foot (48) along approximately one-half the length thereof.

9. An assembly according to any one of claims 2 to 8, wherein the heating means (20) comprises an outer sheath (22) within which the heater coil (23) and heat sensor (34) are arranged, the sheath (22) being supported by a fixing ring (51) around the shaft (17), whereby the heating coil (23) and the sheath (22) are prevented from moving towards the tip (26).

10. An assembly according to claim 9, wherein the fixing ring (51) comprises an opening in which the heat sensor extending portion (41) is held.

11. In a hot runner nozzle assembly (10) including: a housing (12); an externally heatable feed tube (16) in the housing (12), the feed tube (16) including a shaft (17) within the housing (12), and a tip (26) at a bottom end (49) thereof, the improvement comprising: heating means (20) for the feed tube (16), the heating means including a heater that extends towards the tip (26) and a heat sensor (34) that extends beyond the heater towards the tip (26); the heater including a heater coil (23) surrounding the shaft (17) and the heat sensor (34) including an extending portion (41) which extends along the shaft (17) towards the tip (26), the heat sensor extending portion (41) being between the shaft (17)

and the heater coil (23); the heating means (20) further including an outer sheath (22), the heater coil (23) and heat sensor (34) being within the sheath (22); a fixing ring (52) positioned around the shaft (17) for supporting the sheath (22) and for preventing the heating coil (23) and sheath (22) from moving toward the tip (26); and further comprising a shaft foot (48) of a material having extremely low heat conductivity, the shaft foot (48) surrounding the heating coil (23) along a portion of the shaft, thereby reducing heat dissipation from the tip (26) to the housing (12).

**12.** An assembly according to claim 11, wherein the fixing ring (51) has an opening in which the heat sensor extending portion (41) is held.

**13.** An assembly according to claim 11 or claim 12, wherein the shaft (17) includes a positioning groove, the extending portion (41) being arranged in the positioning groove within the heating coil (23).

**14.** An assembly according to any one of claims 11 to 13, wherein the shaft foot (48) is made of titanium.

**15.** An assembly according to claim 14, further comprising an insulating cap (53) surrounding a portion of the shaft foot (48) and isolating it from a tool (27) including the nozzle (10) thereby lengthening a heat transfer path from the tip (26) to the tool (27) including the nozzle (10).

**16.** An assembly according to claim 15, wherein the insulating cap (53) is made of temperature resistant material such as PEEK (polyether etherketone).

**17.** An assembly according to claim 15 or claim 16, wherein the insulating cap (53) surrounds the shaft foot (48) along approximately one-half the length thereof.

**18.** An assembly according to any one of claims 9 to 17, comprising a tube (42) surrounding the shaft (17) and being surrounded by the heater coil (23) for stabilizing a position of the latter during casting of a brass material within the sheath (22), thereby preventing the heater coil (23) from contacting the shaft (17) during casting of the brass.

**19.** An assembly according to claim 18, wherein the tube (42) is perforated to cast the brass around the heater coil (23).

**20.** An assembly according to claim 18 or claim 19, comprising a shaft foot (48) of a material having extremely low heat conductivity, the shaft foot (48) surrounding the heating coil (23) along a portion of the shaft (17), thereby reducing heat dissipation from the tip (26) to the housing (12).

**21.** An assembly according to any one of claims 11 to 20, further comprising an insulating cap (53) surrounding a portion of the shaft foot (48) and isolating it from a tool (27) including the nozzle (10) thereby lengthening a heat transfer path from the tip (26) to the tool (27) including the nozzle (10).

**22.** An assembly according to claim 21, wherein the heating means comprises an outer sheath (22), the heater coil (23) and heat sensor (34) being within the sheath (22) which is supported by a fixing ring (51) around the shaft (17), whereby the heating coil (23) and the sheath (22) are prevented from moving towards the tip (26).

**23.** An assembly according to claim 22, wherein the shaft (17) includes a positioning groove, the heat sensor extending portion (41) being arranged in the positioning groove within the heating coil (23).

**24.** An assembly according to claim 23, wherein the shaft foot (48) is made of titanium.

**25.** In a hot runner nozzle assembly (10) including: a housing (12); an externally heatable feed tube (16) in the housing (12), the feed tube (16) including a shaft (17) within the housing (12), and a tip (26) at a bottom end (49) thereof; the improvement comprising: heating means (20) for the feed tube (16), the heating means including a heater extending towards the tip (26) and a heat sensor (34) extending beyond the heater towards the tip (26); the heater including a heater coil (23) surrounding the shaft (17) and the heat sensor (34) including an extending portion (41) which extends along the shaft (17) towards the tip (26), the heat sensor extending portion (41) being between the shaft (17) and the heater coil (23); and further comprising a shaft foot (48) of a material having extremely low heat conductivity, the shaft foot (48) surrounding the heating coil (23) along a portion of the shaft, thereby reducing heat dissipation from the tip (26) to the housing (12).

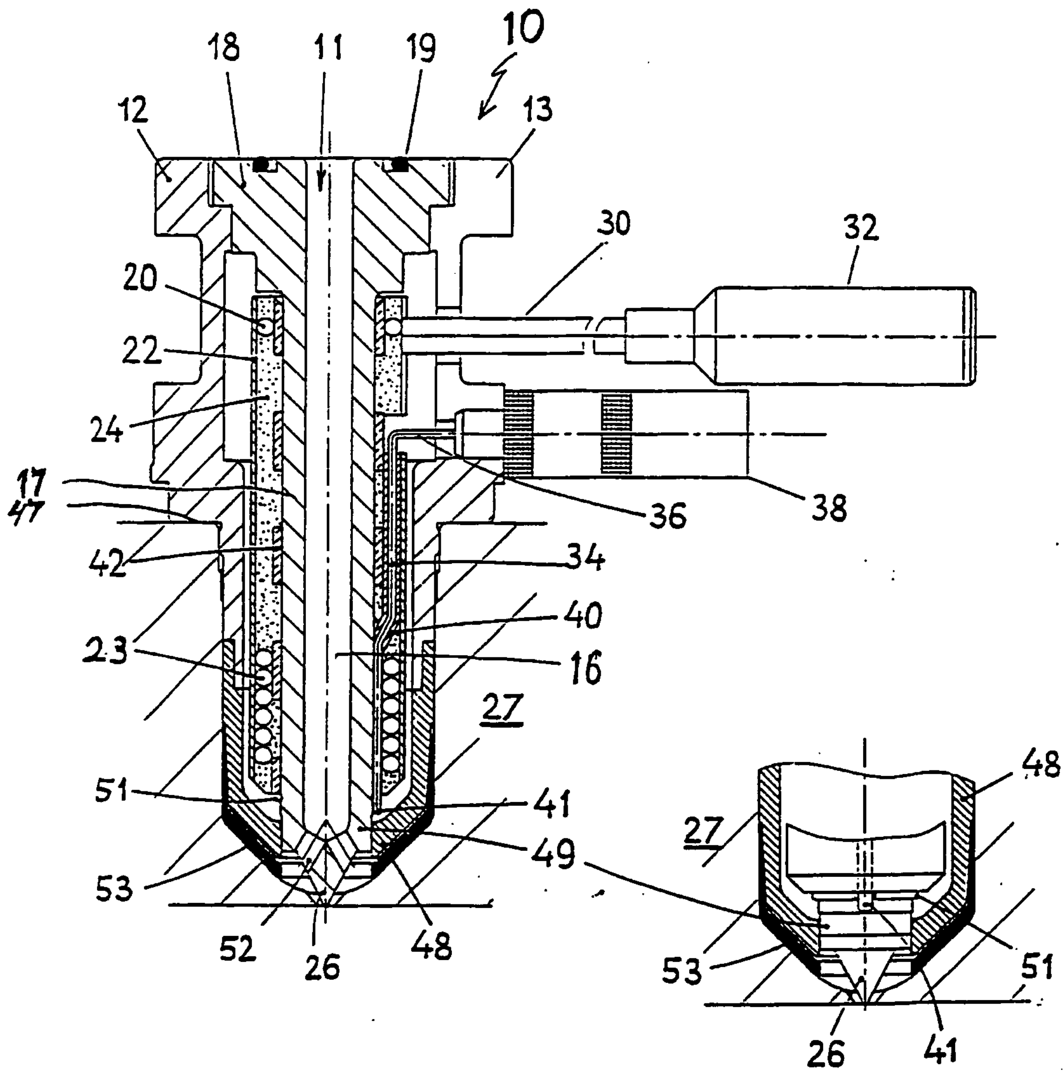
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Fig. 1

Fig. 2

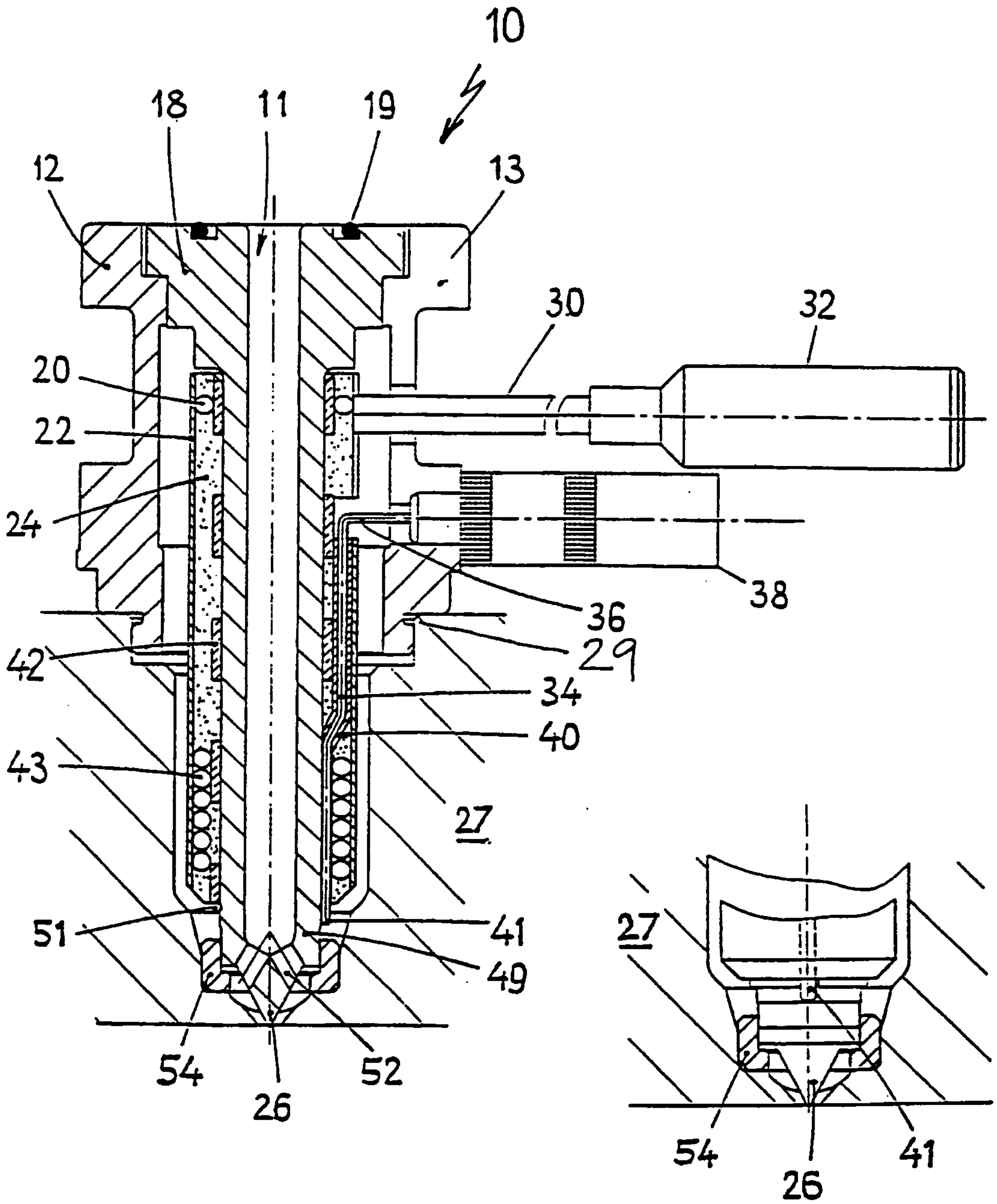
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Fig. 3

Fig. 4

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# EUROPEAN SEARCH REPORT

Application Number
EP 97 12 2469

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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# EUROPEAN SEARCH REPORT

Application Number
EP 97 12 2469

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| | | | TECHNICAL FIELDS SEARCHED (Int.Cl.6) |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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